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SUMMARY

The flame response in realistic situations is governed by the detailed kinetics of chemical reactions, the diffusion of heat and mass, and the aerodynamic processes of stretching, turbulence, and large-scale flow nonuniformity. During the reporting period good progress was made in the areas of turbulent flame propagation, soot formation in diffusion flames, and experimental and numerical determination of the laminar flame speed of methane/air mixtures under reduced and elevated pressures.



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11. "Experimental and Numerical Determination of Laminar Flame Speeds of Methane/"Air" Mixtures as Function of Stoichiometry, Pressure, and Flame Temperature," by D. L. Zhu, F. N. Egolfopoulos, and C. K. Law, to appear in Proc. of Twenty-Second Combustion Symposium.
12. "Experiments on Soot Extinction by Aerodynamic Straining in Counterflow Diffusion Flames," by D. X. Du, R. L. Axelbaum, W. L. Flower and C. K. Law, to appear in Proc. of Twenty-Second Combustion Symposium.
13. "Dilution and Temperature Effects of Inert Addition on Soot Formation in a Counterflow Diffusion Flame," by R. L. Axelbaum, W. L. Flower and C. K. Law, submitted.
14. "Laminar Flame Speeds of Methane/Air Mixtures Under Reduced and Elevated Pressures," by F. Egolfopoulos, P. Cho, and C. K. Law, submitted.

RESEARCH PERSONNEL

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situations under which the mass burning rate of the flame, $\rho_u S_L^0$, decreases with increasing pressure. This is the first conclusive experimental demonstration of such a phenomenon, which is caused by the progressive dominance of the chain termination reaction with increasing pressure.

2. Preferential Diffusion and Concentration Modification in Sooting Counterflow Flames

An experimental investigation has been conducted on the influence of the mobility of inert additives on soot formation in counterflow propane/enriched-air and ethylene/air diffusion flames. By using helium, neon, argon or krypton as the inert additive, results show that while the inert mobility has practically no effect when a small amount of the inert is added to the oxidizer side, the influence is significant when it is added to the fuel side in that krypton, being the least mobile inert, yields the least. By relating the spatially-resolved soot volume fractions to the corresponding profiles of temperature, velocity and species concentration, it is demonstrated that this influence on soot loading is likely caused by concentration modifications of the fuel and the soot precursors due to different mobilities of the inert additives.

3. Soot Extinction by Aerodynamic Straining in Counterflow Diffusion Flames

An experimental study has been performed with axisymmetric counterflow diffusion flames to investigate the relevant soot extinction limits in these aerodynamically-strained flames. The sooting limits are defined by the critical strain rate at which either soot luminosity, soot particle scattering, or fluorescence is negligible compared to the appropriate background signal. The critical strain rate is found to be greatest for the sooting limit based on the fluorescence signal, and least for that based on luminosity. The fluorescence signal, attributed to polycyclic aromatic hydrocarbons, yields a limit that can be interpreted as the extinction of the large soot precursors and is suggested to be an appropriate limit for identifying a completely nonsooting flame condition. The separate effects of flame temperature and fuel concentration on the critical strain rates for soot extinction have also been studied. Results show that they are both important parameters affecting the sooting limits.

4. Velocity and Scalar Fields of Turbulent Premixed Flame in Stagnation Flow

Detailed experimental measurements of the scalar and velocity statistics of premixed methane/air flames stabilized by a stagnation plate are reported. Conditioned and unconditioned velocity of two components and the reaction progress variable are measured by using a two-component laser Doppler velocimetry technique and Mie scattering technique, respectively. Experimental conditions cover equivalence ratios of 0.9 and 1.0,

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